1. Name of Experiment/Project/Collaboration: KamLAND and KamLAND-Zen
2. Physics Goals
    - Primary: search for ^{136}Xe neutrinoless double beta decay (KamLAND-Zen)
    - Secondary: sterile neutrino search (under consideration)
    - Continuing Reactor and Geoneutrino Analyses
3. Expected location of the experiment/project: Kamioka, JAPAN
4. Neutrino source:
    - Neutrinoless double beta decay: ^{136}Xe
    - Sterile neutrino search: ^{8}Li or ^{144}Ce decay at rest source
5. Primary detector technology: liquid scintillator
6. Short description of the detector: KamLAND consists of one kton of liquid scintillator ($CH_{1.9}$) contained in a 13 m diameter thin transparent balloon. This balloon is surrounded by non-scintillating buffer oil contained in an 18 m diameter spherical stainless steel vessel. Scintillation and Cherenkov photons from the scintillator and buffer oil are detected by 1879 photomultiplier tubes mounted on the inner wall of the stainless steel vessel. A water Cherenkov veto detector surrounds the stainless steel vessel. In the KamLAND-Zen Phases 1 and 2, a 3.08 m diameter balloon containing Xe (Phase 1: 320 kg, Phase 2: 383 kg; 90.6% enriched ^{136}Xe) loaded liquid scintillator is located at the center of KamLAND. The Xe-loaded balloon occupies less than 2% of the total active scintillator volume of KamLAND and other physics can be performed concurrently with the remaining volume during the KamLAND-Zen phases.
7. List key publications and/or archive entries describing the project/experiment: K. Eguchi *et al.* (KamLAND Collaboration), “First Results from KamLAND: Evidence for Reactor Anti-Neutrino Disappearance”, Phys. Rev. Lett. **90**, 021802 (2003); T. Araki *et al.* (The KamLAND Collaboration), “Measurement of Neutrino Oscillation with KamLAND: Evidence of Spectral Distortion”, Phys. Rev. Lett. **94**, 081801 (2005); T. Araki et al. (The KamLAND Collaboration), “Experimental investigation of geologically produced antineutrinos with KamLAND”, Nature **436**, 499-503 (2005); S. Abe, et al. (The KamLAND Collaboration), “Precision Measurement of Neutrino Oscillation Parameters with KamLAND”, Phys. Rev. Lett. **100**, 221803 (2008); A. Gando *et al*. (The KamLAND Collaboration), “Constraints on θ_{13} from a three-flavor oscillation analysis of reactor antineutrinos at KamLAND”, Phys. Rev. D **83**, 052002 (2011); A. Gando *et al*. (The KamLAND-Zen Collaboration), “Limit on Neutrinoless $\beta\beta$ Decay of ^{136}Xe from the First Phase of KamLAND-Zen and Comparison with the Positive Claim in ^{76}Ge”, Phys. Rev. Lett. **110**, 062502 (2013).
8. Collaboration
    - Institution list:
        1. Tohoku University JAPAN
        2. Kavli IPMU JAPAN
        3. Osaka University JAPAN
        4. Tokushima University JAPAN
        5. University of Alabama, Tuscaloosa USA
        6. University of California, Berkeley USA
        7. University of Hawaii, Manoa USA
        8. Lawrence Berkeley National Laboratory USA
        9. University of Tennessee, Knoxville USA
        10. Triangle Universities Nuclear Laboratory USA

11. University of Washington USA
12. Nikhef NETHERLANDS
13. Massachusetts Institute of Technology USA

- Number of present collaborators: 50
- Number of collaborators needed: unknown

9. R&D
    - Neutrinoless Double Beta Decay Search (KamLAND-Zen)
        - In-situ balloon and scintillator purification:
            - Critical: reduces the background in the $\beta\beta0\nu$ region of interest.
            - Completed: an order of magnitude background reduction was achieved.
            - Purification techniques can be applied to other liquid scintillator detectors.
        - Scintillating balloon film
            - Critical: improves the identification and rejection of radioactive backgrounds that decay in the balloon film.
            - Status: in progress.
        - Pressurized Xe loading
            - Critical: increases target mass without increasing detector size.
            - Status: in progress.
        - High sensitivity imaging
            - Not critical: would provide β/γ discrimination capabilities and improve background rejection.
            - Status: under study.
    - Sterile Neutrino Search
        - High intensity (~10^{15} ν/sec) ^{8}Li decay at rest anti-neutrino source development.
            - IsoDAR solely undertakes this R&D work with approval from KamLAND.
        - 75 kCi ^{144}Ce anti-neutrino source development.
            - An R&D effort was preformed by CeLAND (arXiv:1312.0896) in 2013. A decision was made in early 2014 to deploy the source in Borexino (CeSOX) and a deployment of a ^{144}Ce source in KamLAND appears unlikely in the near future.
        - Medium intensity (10^{13} ν/sec) ^{8}Li decay at rest anti-neutrino source investigation.
            - The feasibility of producing 10^{13} ^{8}Li decays per second through the ^{8}Li(d,p)^{7}Li reaction with a 10 mA 2 MeV deuteron beam is currently under investigation.
10. Primary physics goal expected results/sensitivity:
    - KamLAND-Zen Phase 1 & 2 combined current limit: $T^{0\nu}(^{136}Xe) > 2.6 \times 10^{25}$ years ($m_{\beta\beta} < 140$-280 meV (90% CL)).
    - KamLAND-Zen Phase 1 & 2 combined projected limit: $T^{0\nu}(^{136}Xe) > 3 \times 10^{25}$ years at the end of 2015.
    - KamLAND-Zen next phase (scintillating balloon, 600 to 800 kg enriched Xe) projected limit from Phase 1 & 2: $T^{0\nu}(^{136}Xe) > 1$ or 2×10^{26} years
    - KamLAND2-Zen (improved energy resolution, 1000 kg enriched Xe): probe inverted hierarchy region.
    - List other experiments that have similar physics goals: CUORE, EXO, GERDA, MJD, SNO+
11. Secondary Physics Goal

- Expected results/sensitivity: the sensitivity of a KamLAND-like detector in a sterile neutrino search has been studied by IsoDAR (e.g. A. Bungau, *et al.* Phys. Rev. Lett. **109**, 141802 (2012)).
- Sensitivity to non-standard neutrino interactions has also been explored and is unique to accelerator approach relative to the reactor or source approach (J.M. Conrad,*et al.* Phys.Rev. D89 (2014) 072010).
- List other experiments that have similar physics goals: IsoDAR, CeSOX, Prospect

12. Experimental requirements
    - ^{136}Xe neutrinoless double beta decay search:
        - KamLAND-Zen phases: data taking through end of 2018
        - KamLAND2-Zen: 5 years data taking
    - Sterile neutrino search:
        - 20000 or more detected inverse beta decay events (e.g. 10^{13} ν/sec ^{8}Li decay at rest anti-neutrino source running for 5 years).
        - 12 m baseline or shorter
        - 6.5%/$\sqrt{E[\mathrm{MeV}]}$ energy resolution (or better)
        - 15 cm spatial resolution (or better)
13. Expected Experiment/Project time line
    - KamLAND-Zen Phase 1:
        - Completed in 2012
    - KamLAND-Zen Phase 2:
        - Currently running (through end of 2015)
        - 1st results announced at Neutrino 2014
    - KamLAND-Zen next phase (scintillating balloon, from 600 to 800 kg enriched Xe):
        - Balloon deployment and 1st data in 2016
        - 2 year data taking is planned
14. Estimated cost range
    - The construction and operational costs of KamLAND-Zen are entirely funded by the Japanese groups.
    - The financial contributions the US groups are minimal – primary for the maintenance of legacy US equipment (front-end electronics, PMT high voltage system, calibration source deployment systems).
    - There is an independent US R&D effort to develop a directional liquid scintillator that results of which may be incorporated in KamLAND2-Zen.
15. The Future
    - KamLAND2-Zen
        - Improved energy resolution: $\sigma(2.6\ \mathrm{MeV})/E$ 4 % (now) to < 2.5%
            - Double photocathode coverage
            - High quantum efficiency photomultiplier tubes
        - 1000 kg enriched Xe
          Goal: probe inverted hierarchy region ($m_{\beta\beta}$ < 20 meV) in 5 years